

# Impacts and associated previsibility of a persistent NAO forcing

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AGU General Assembly 2019, San Francisco

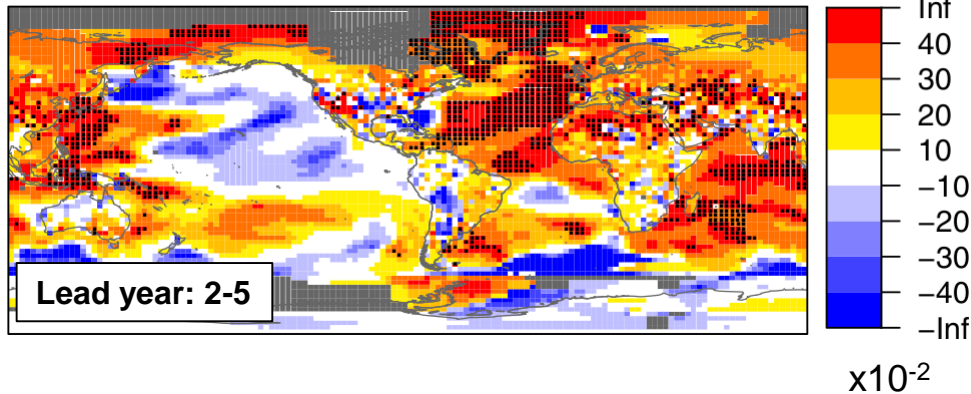


**INADEC: H2020-MSCA-800154**

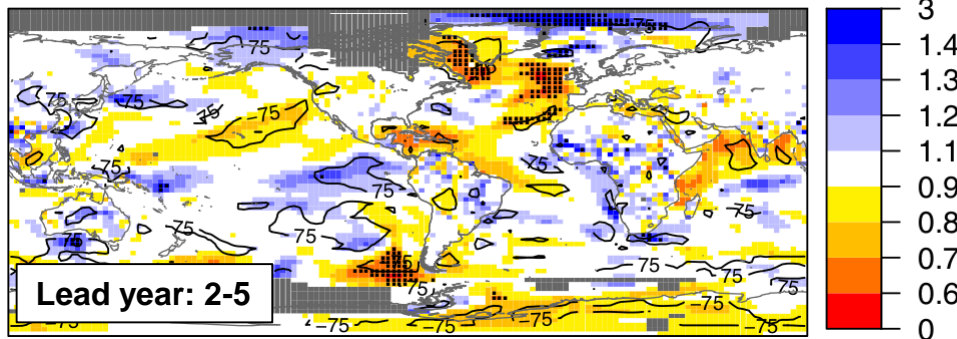
# North Atlantic Subpolar Gyre (SPG) predictability

## Annual SST / T2m prediction skill score

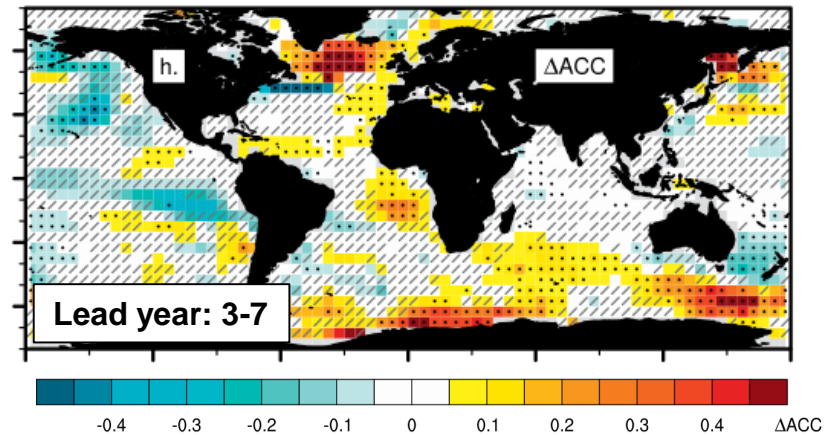
$$1 - \frac{RMSE_{INI}}{RMSE_{clim}}$$



$$\frac{RMSE_{INI}}{RMSE_{NoINI}}$$

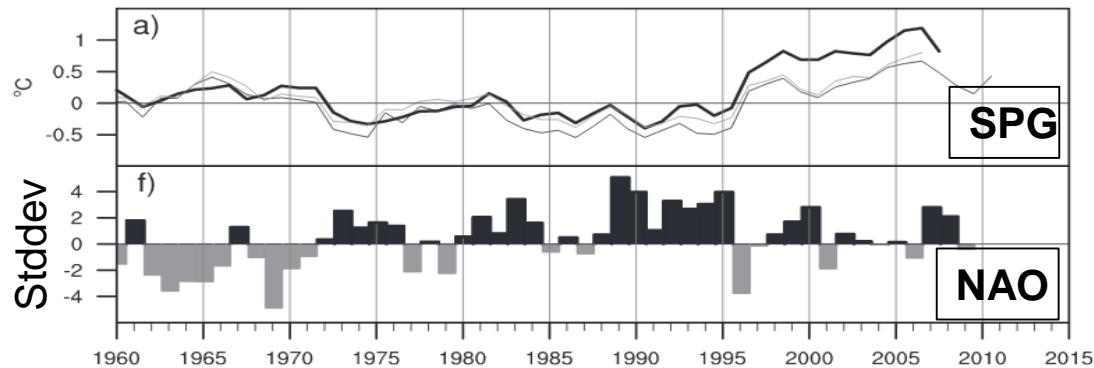
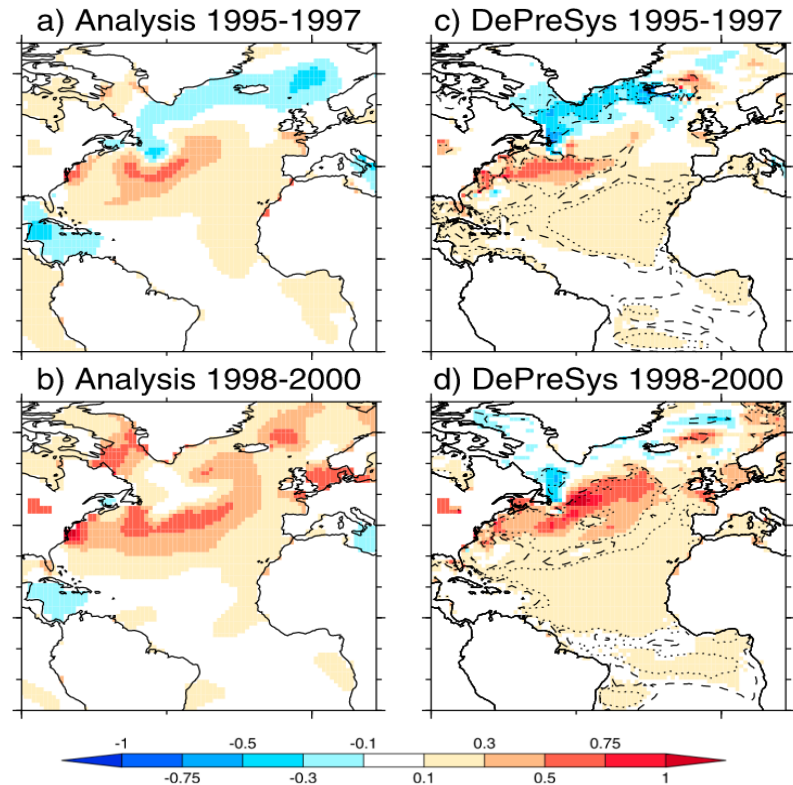
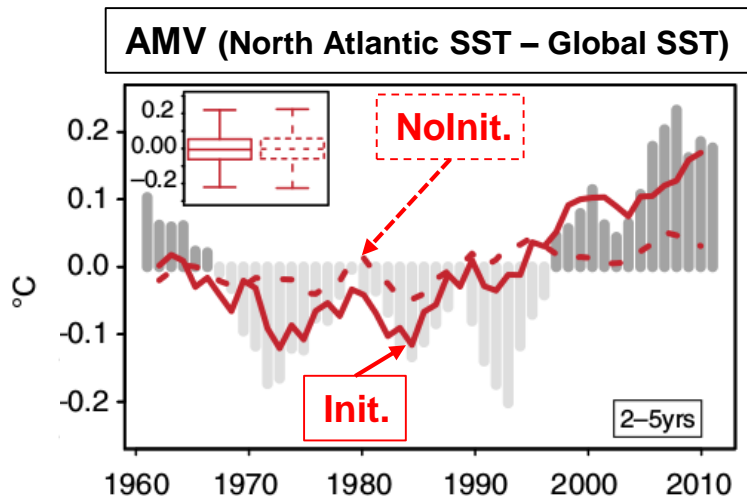


$$\Delta ACC = ACC_{INI} - ACC_{NoINI}$$

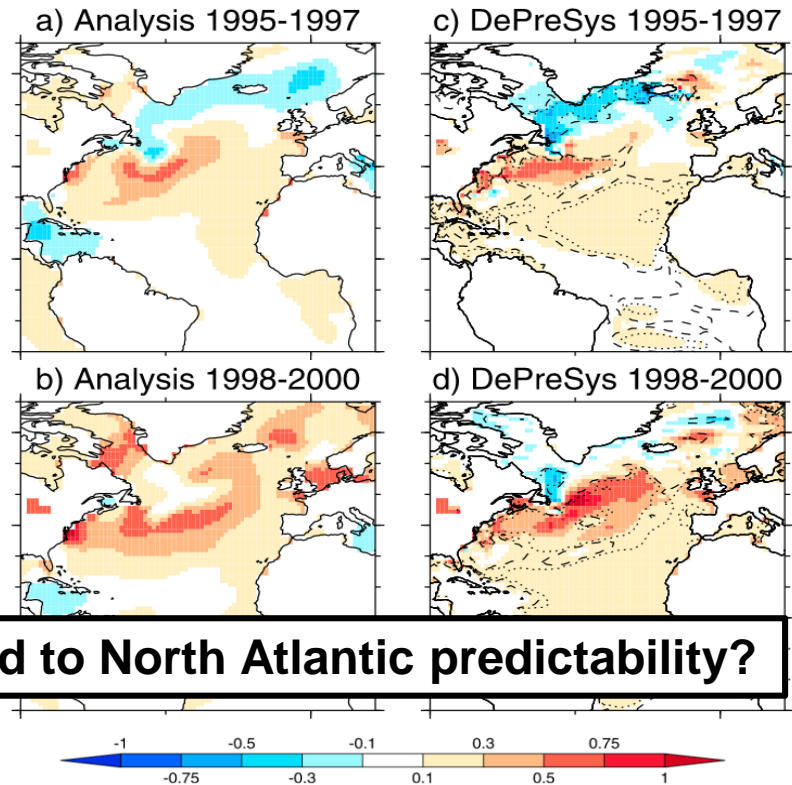
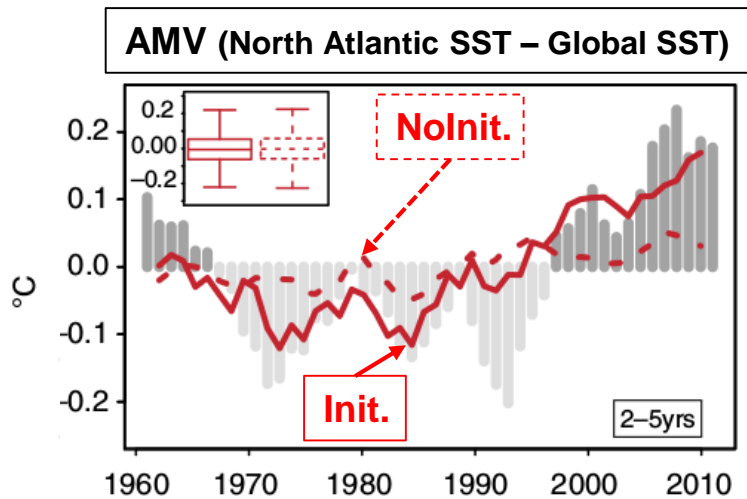


The North Atlantic subpolar gyre (SPG) is the most predictable region at multi-year timescales

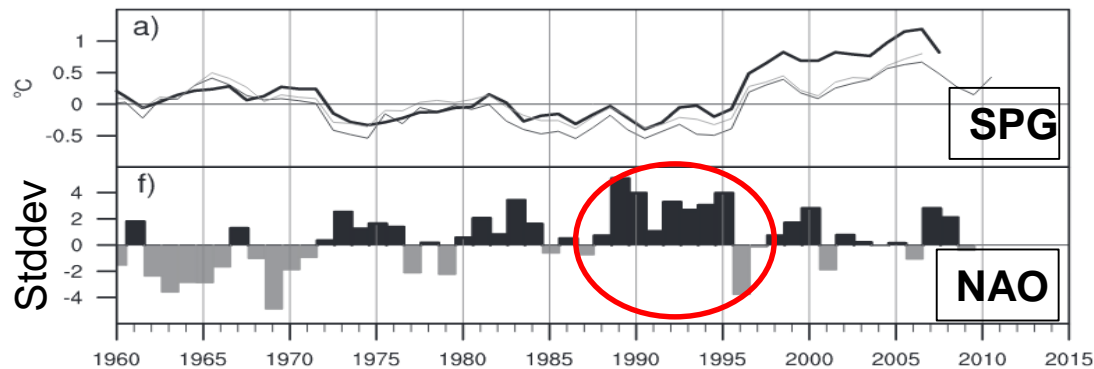
# Driving mechanism of the North Atlantic SPG variability



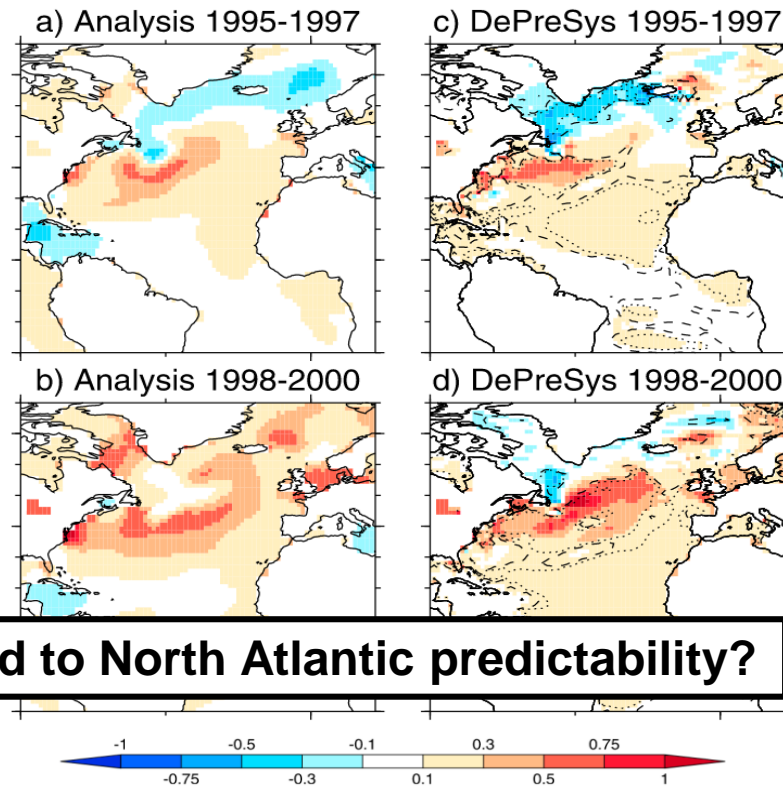
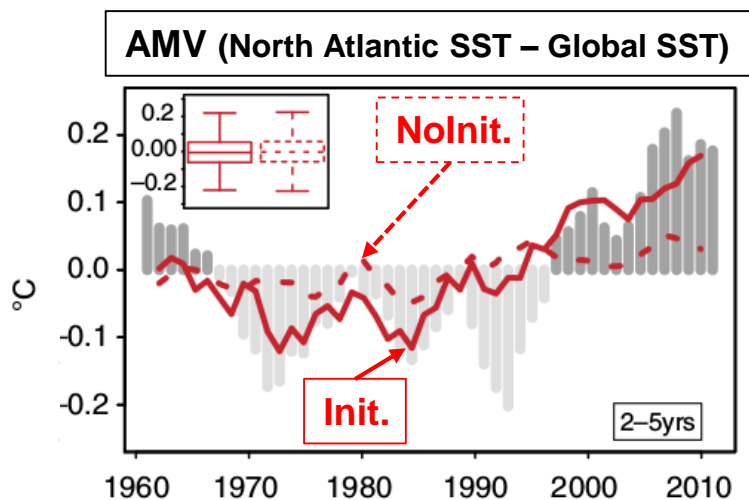
# Driving mechanism of the North Atlantic SPG variability



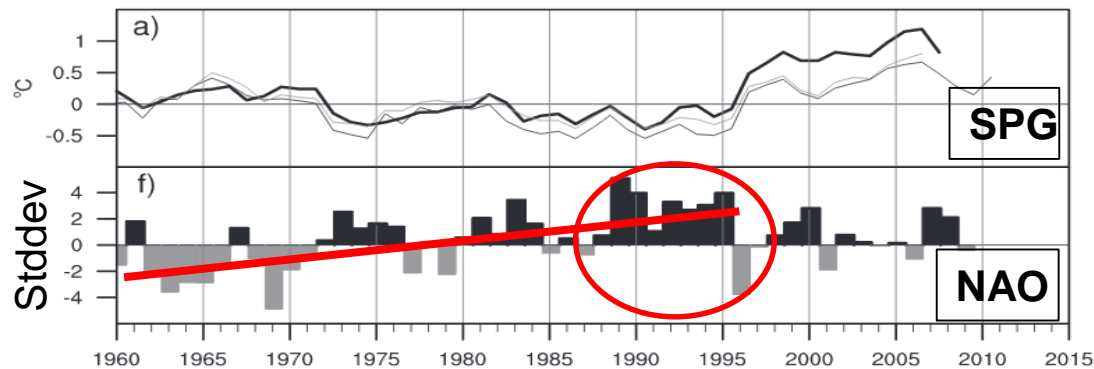
**What kinds of atmospheric forcing lead to North Atlantic predictability?**



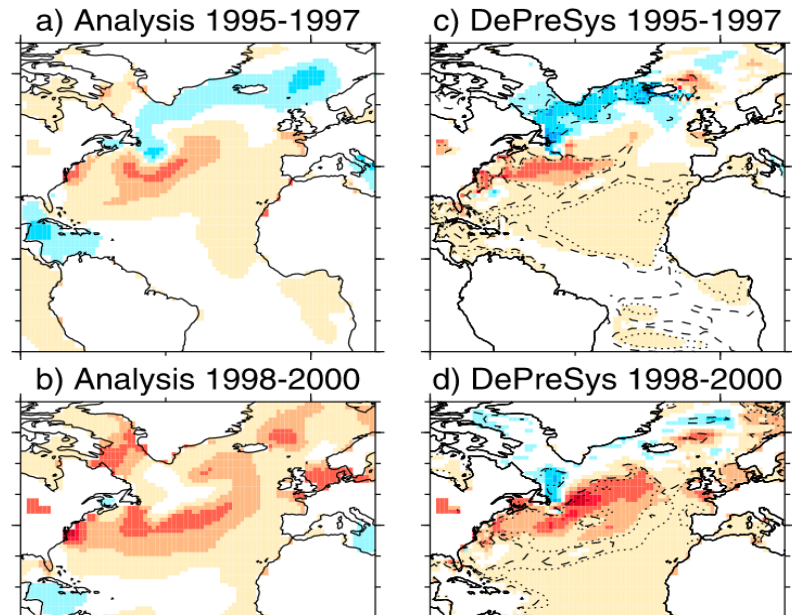
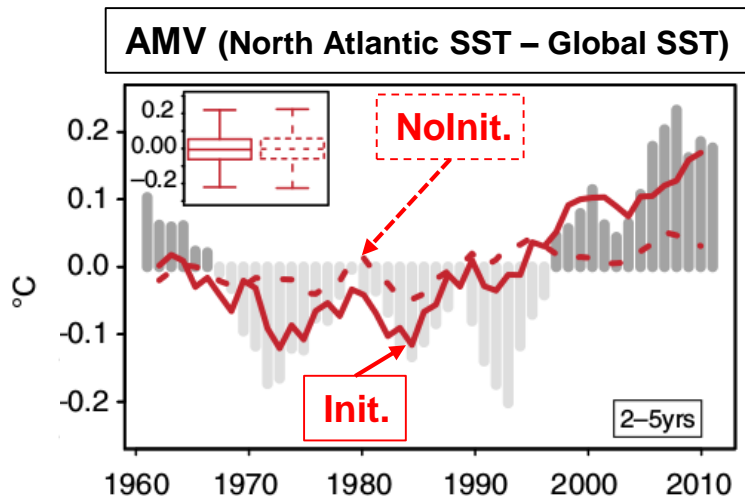
# Driving mechanism of the North Atlantic SPG variability



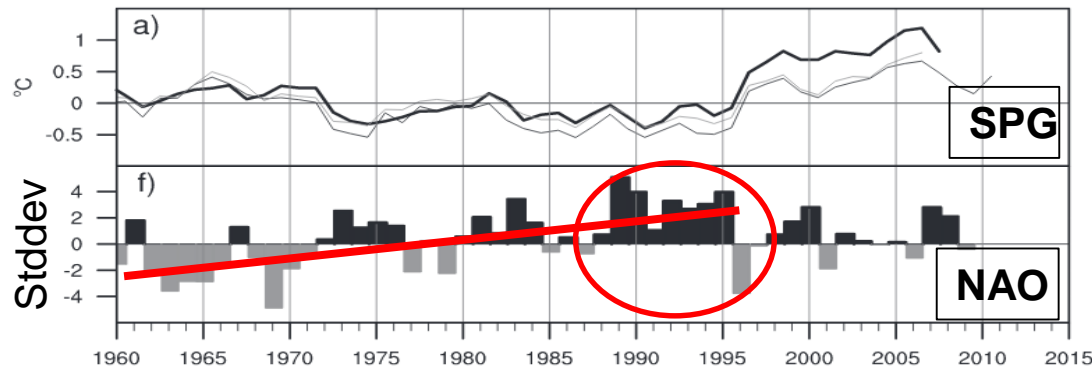
**What kinds of atmospheric forcing lead to North Atlantic predictability?**



# Driving mechanism of the North Atlantic SPG variability



**What kinds of atmospheric forcing lead to North Atlantic predictability?  
How probable this forcing is likely to happen?**





# This study:

**Proposal:** North Atlantic Oscillation (NAO) drives North Atlantic SPG variability

**Questions:**

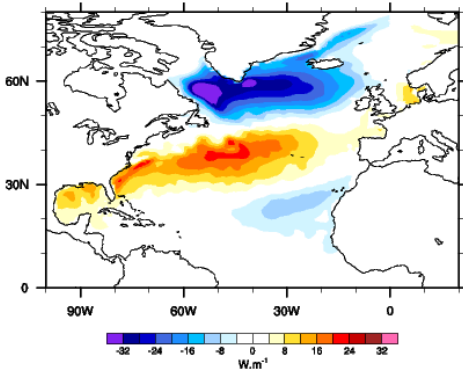
- Do models confirm such link?
- What kind of NAO forcing leads to predictable oceanic response?

**Method:** evaluate climate response in idealized persistent NAO forcing simulations

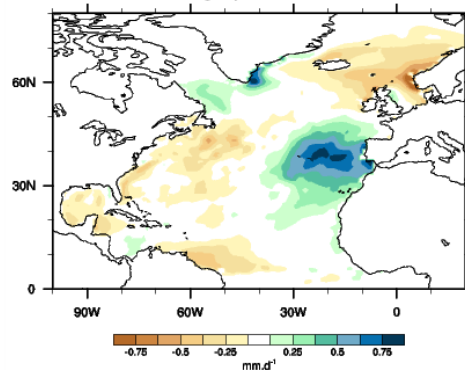
# The idealized NAO Experiments

Regression of surface fluxes from ERA-Interim on DJFM Hurrell NAO:

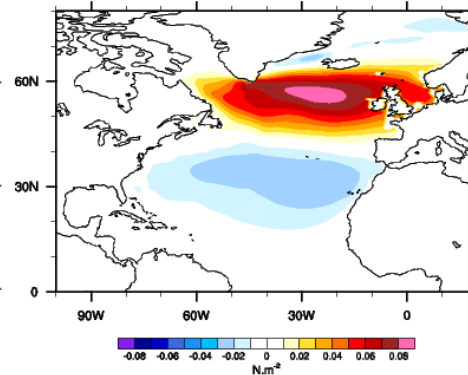
Heat fluxes



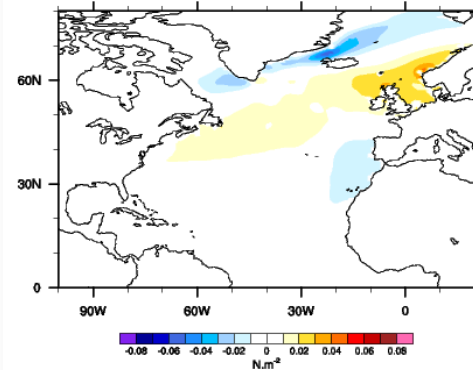
Fresh water fluxes



Zonal wind stress

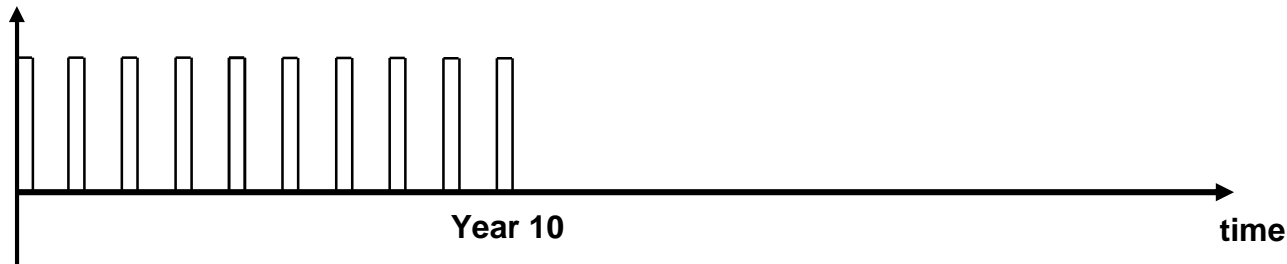


Meridional wind stress



On top of free model coupling surface fluxes, addition of observed NAO fluxes  
30-yr long simulations: extra forcing for 10 years, model adjusts for remaining 20 years.

Extra fluxes



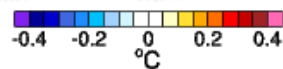
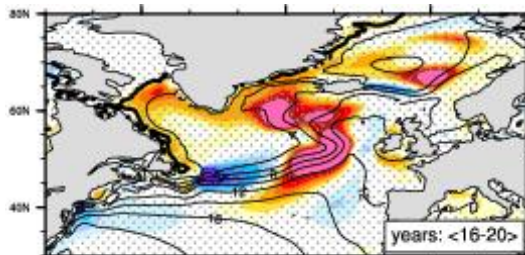
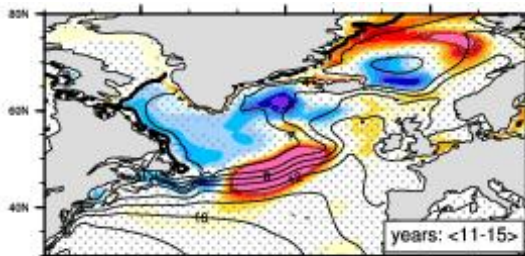
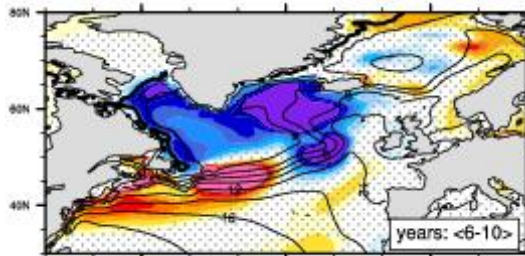
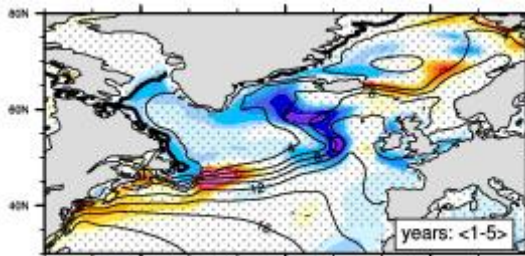
3 coupled models:

- EC-Earth3P
- IPSL-CM6A-LR
- ( ➤ HadGEM3-GC3.1 )

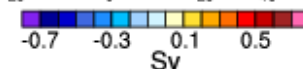
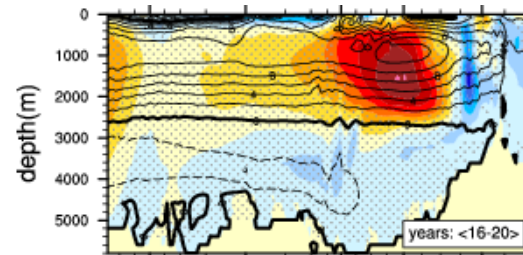
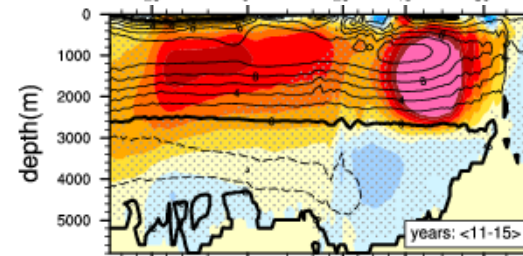
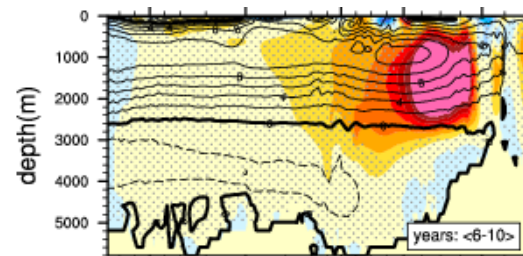
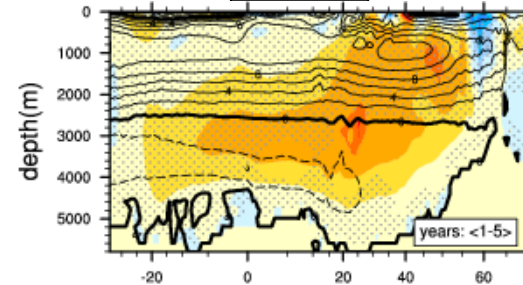


# IPSL-CM6A-LR response to 10-yr NAO forcing

Thetao@0-500m



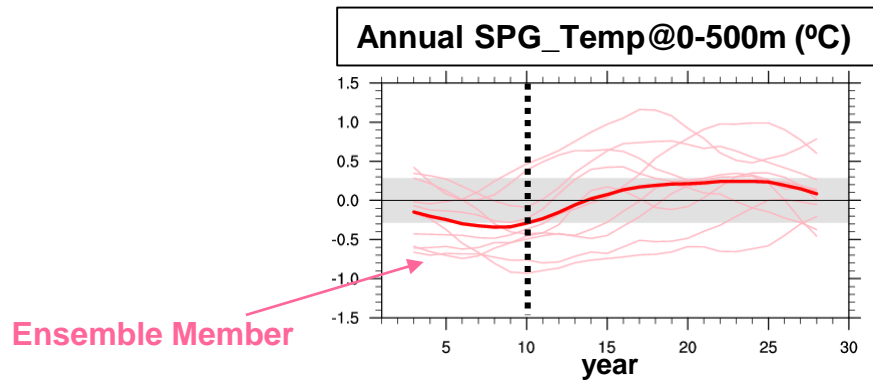
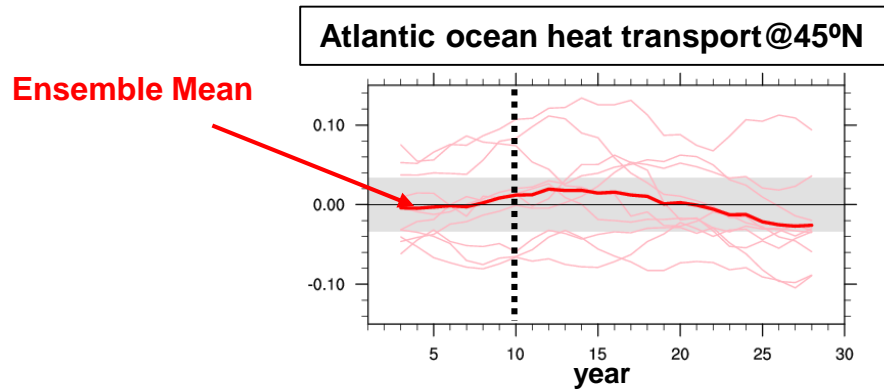
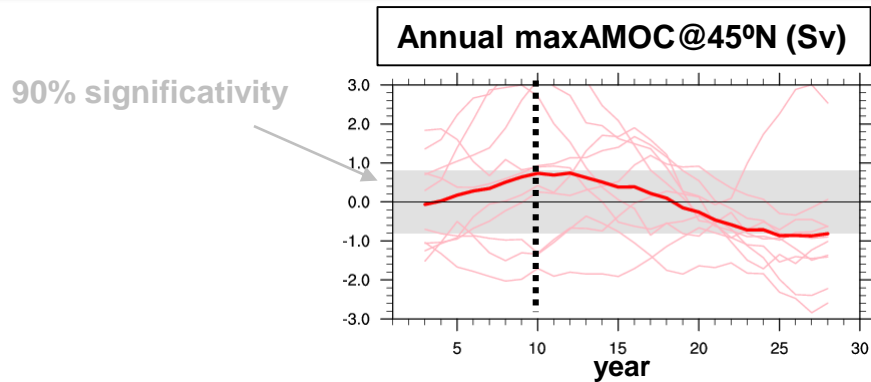
AMOC



NAO forcing

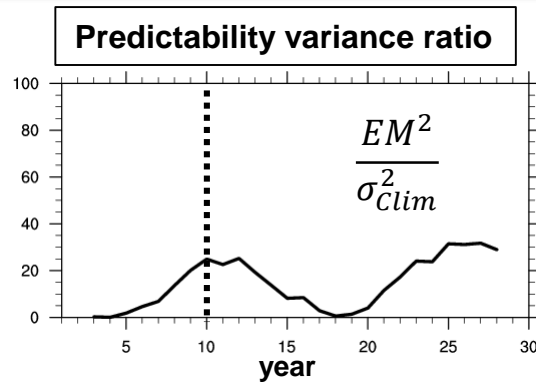
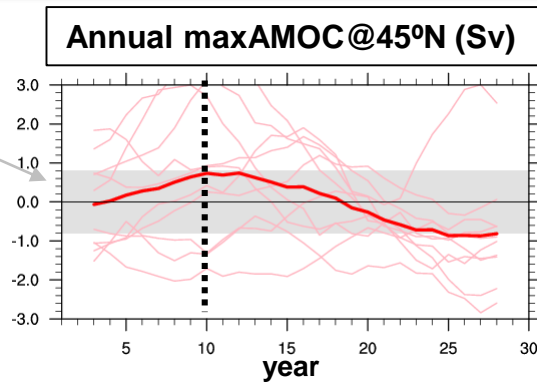
Free to adjust

# IPSL-CM6A-LR response to 10-yr NAO forcing

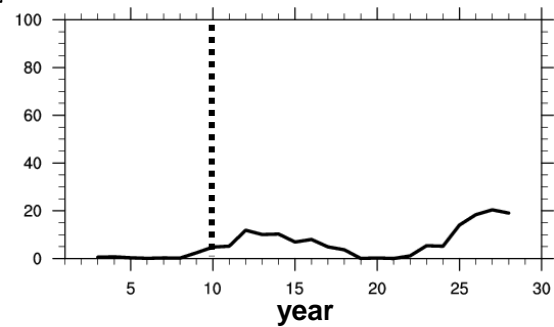
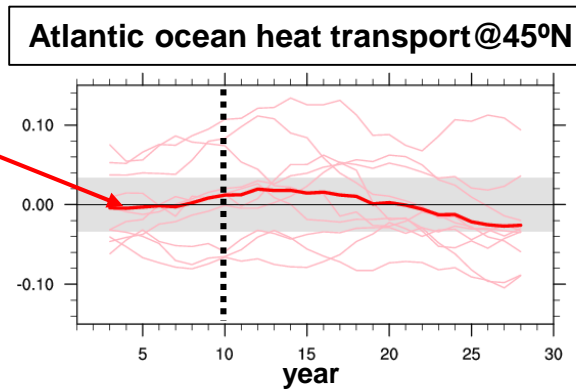


# IPSL-CM6A-LR response to 10-yr NAO forcing

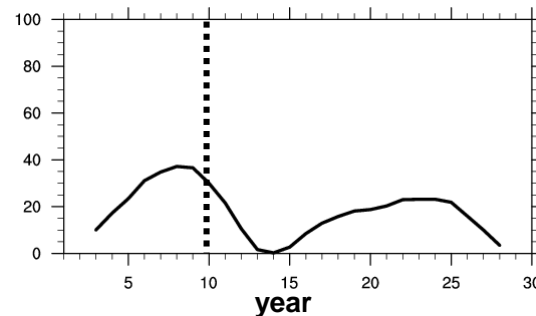
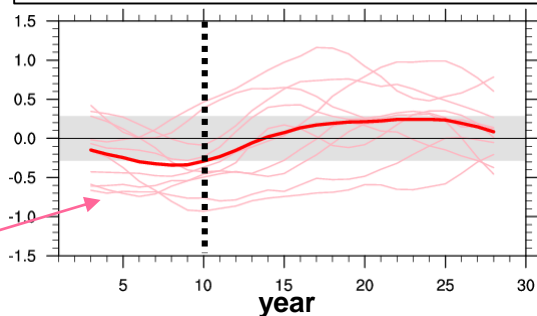
90% significativity



Ensemble Mean

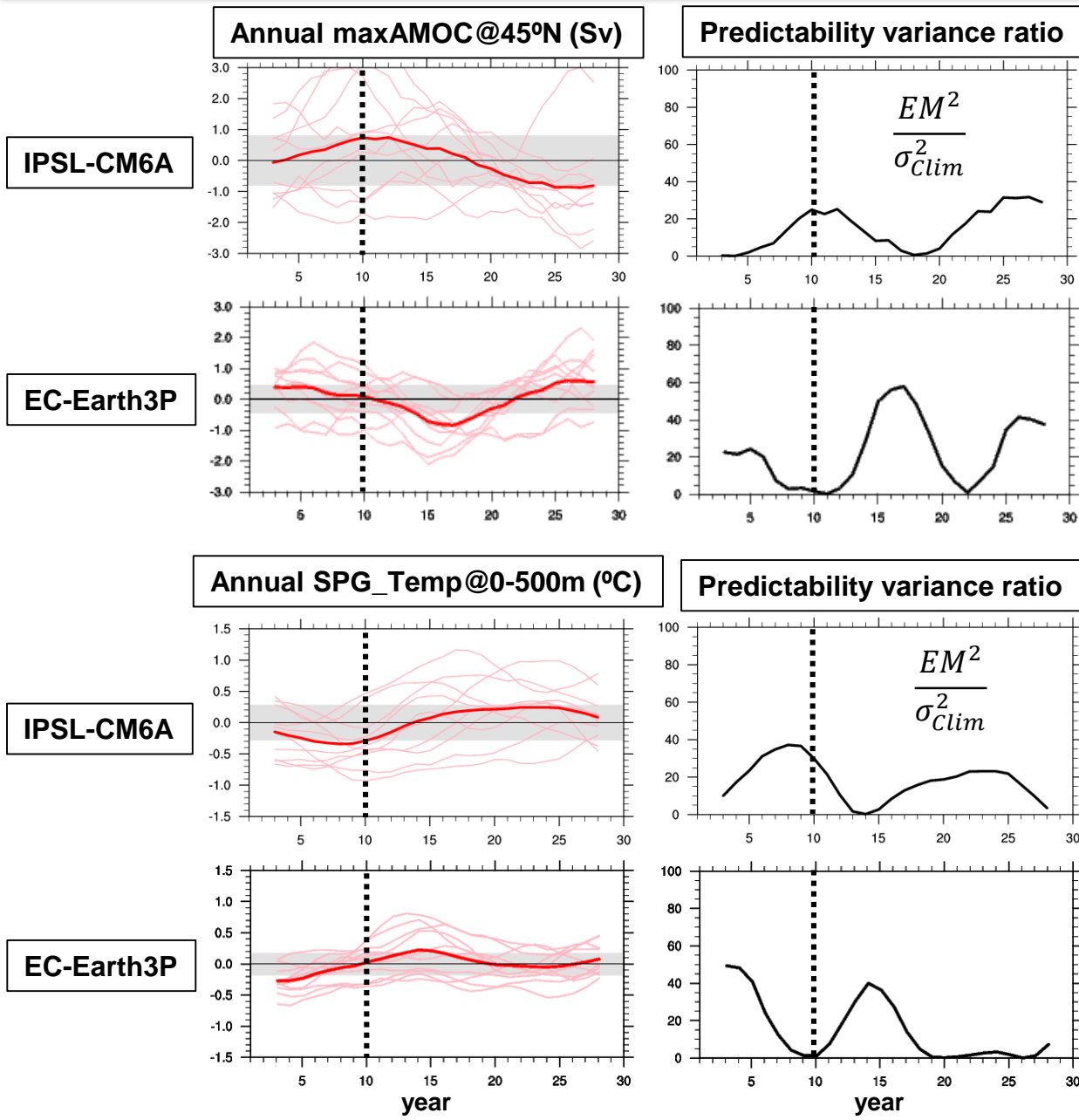


**Annual SPG\_Temp@0-500m (°C)**



Ensemble Member

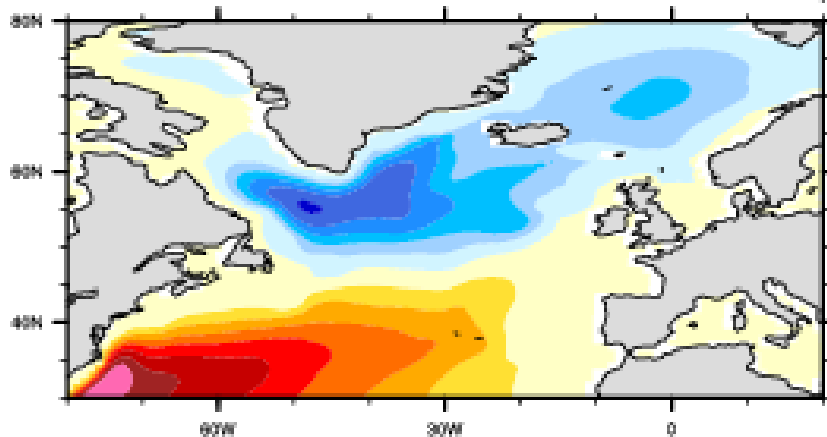
# IPSL-CM6A-LR vs EC-Earth3P response to 10-yr NAO forcing



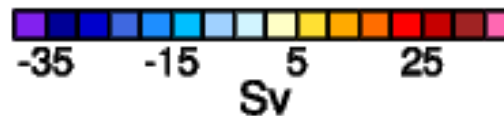
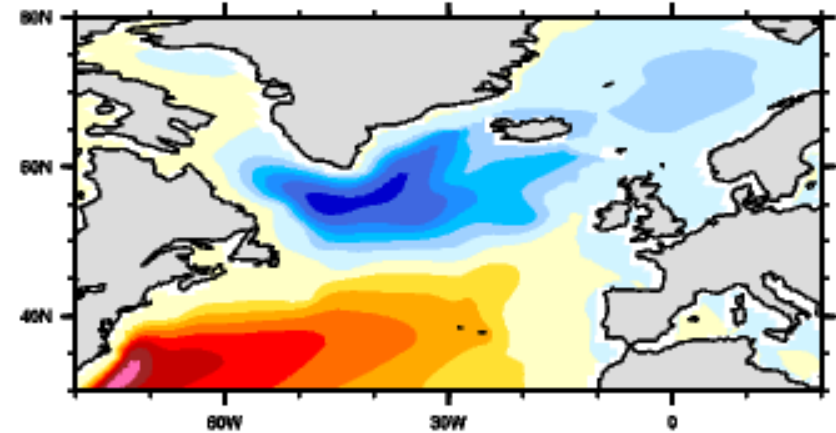
# IPSL-CM6A-LR vs EC-Earth3P response to 10-yr NAO forcing

Climatological Barotropic streamfunction

IPSL-CM6A

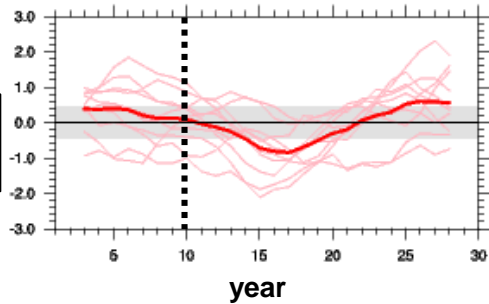


EC-Earth3P



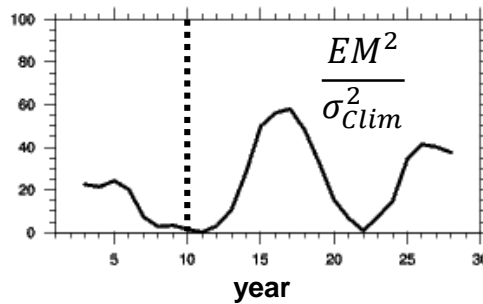
# EC-Earth3P response to 10-yr vs 5-yr NAO forcing

Annual maxAMOC@45°N (Sv)



EC-Earth3P  
10yr forcing

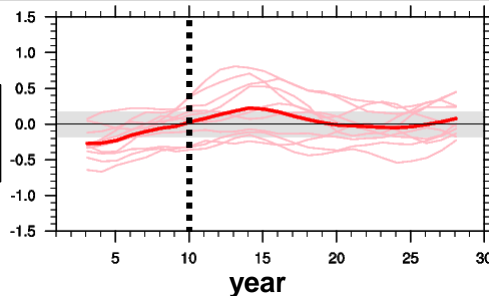
Predictability variance ratio



Assuming NAO has a white  
noise spectrum:

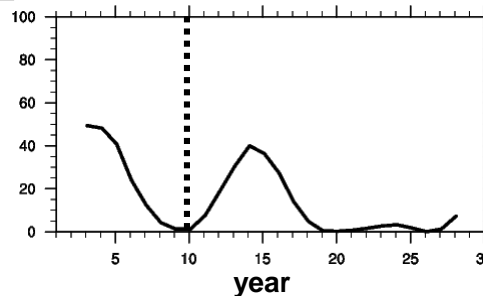
Prob. of 10yr 1Sig NAO = 1/1000

Annual SPG\_Temp@0-500m (°C)



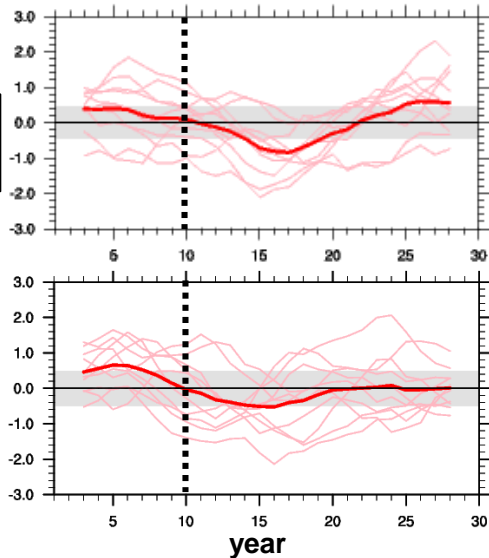
EC-Earth3P  
10yr forcing

Predictability variance ratio

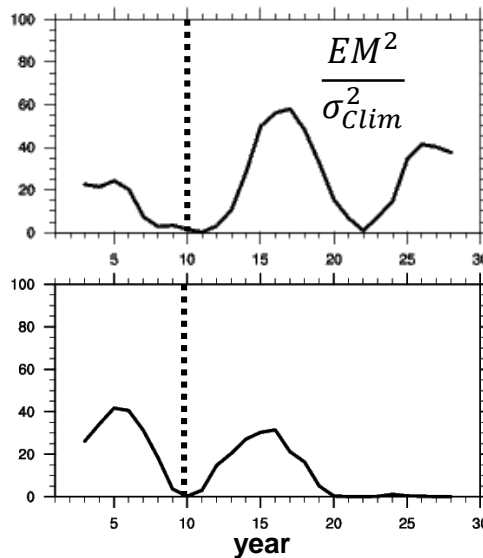


# EC-Earth3P response to 10-yr vs 5-yr NAO forcing

Annual maxAMOC@45°N (Sv)



Predictability variance ratio

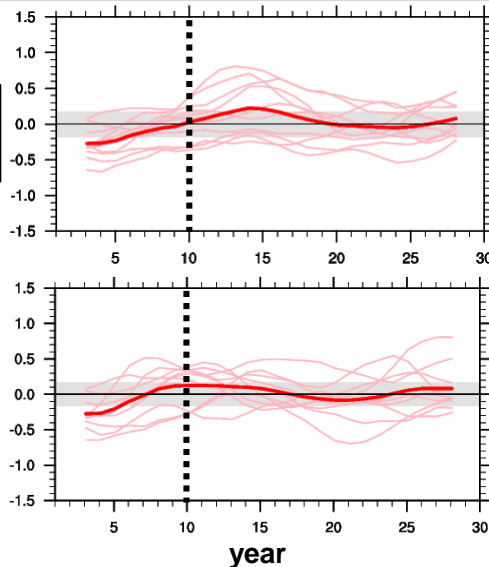


Assuming NAO has a white noise spectrum:

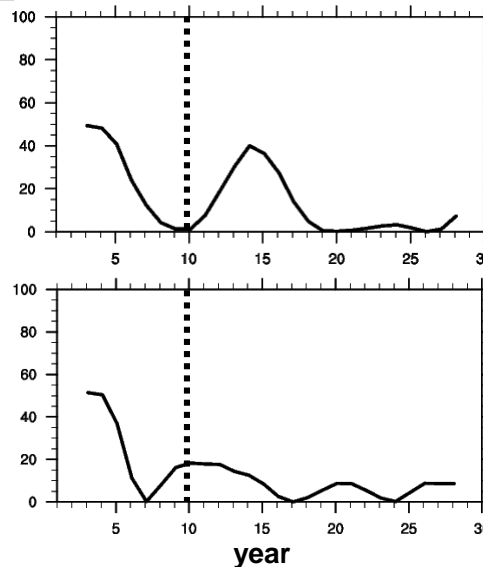
Prob. of 10yr 1Sig NAO = 1/1000

Prob. of 5yr 1Sig NAO = 3/100

Annual SPG\_Temp@0-500m (°C)



Predictability variance ratio





# Summary

**Adding observed NAO+ surface fluxes for 10 years in IPSL-CM6A-LR and EC-Earth3P:**

- **Both models simulate a warming trend of the SPG HC500 following the forcing**
- **Timing of the warming trend not the same between the 2 models**
- **Explained 40% (20%) of the SPG HC500 variance 5 (15) years later in EC-Earth3P (IPSL-CM6A-LR)**
- **Warming driven by an increase of the AMOC@45°N, which is more predictable than the heat transport increase**
- **Dividing by 2 the length of the NAO forcing divides by 2 the amplitude of the SPH HC500 response**
- **To continue with HadGEM3, and to compare with DCPA-A prediction skill...**

**Thank you!**